

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent application of

Jyoti Kiron BHARDWAJ et al.

: Group Art Unit 1765

Serial No. 09/674,925

: Examiner Ahmed, Shamim

Filed November 8, 2000:

METHOD AND APPARATUS FOR STABILIZING A PLASMA :

**DECLARATION of DR. LESLIE LEA
UNDER 37 C.F.R. ¶1.132**

Commissioner for Patents
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Alexandria VA 22314

Sir:

In connection with the above-identified application, I hereby declare as follows:

1. I am presently the Deputy Chief Executive Officer and Chief Technical Officer at Surface Technologies Systems Plc, the assignee of record of the above-identified application.
2. I hold Doctorate and Masters degrees in the Science and Applications of Electric Plasmas from Oxford University, with a first degree in Physics (1st class honors) from Southampton University. After graduating, I worked as a Post Doctoral Research Assistant at Oxford University, working closely with the Culham Laboratory of the United Kingdom Atomic Energy Authority (UKAEA). After two years I joined the UKAEA, (later AEA Technology), at the Culham Laboratory, as a Research and Development Scientist gaining ten years

experience in scientific project management, the design of plasma and ion beam systems, and management of the construction and testing of these systems.

Applications on which I have worked include heating and diagnostics for plasmas in nuclear fusion experiments, commercial plasma processing systems, and plasmas related to defense purposes. I have significant experience in designing and constructing plasma diagnostics, and in constructing computer models of plasma systems. I am a Member of the UK Institute of Physics, and have served on one of its Committees.

3. I have reviewed the prosecution history of US 09/674,925, in particular the U.S.P.T.O. Examiner's comments contained in the Office Action dated May 18, 2006. As best understood, the Examiner appears to take the position that US Patent No. 3569777 (Beaudry) discloses "an automatic impedance matching network which is directly relating the changes in the process parameter". However, as explained below, this is not the case.
4. The invention of US 09/674,925 assists in maintaining efficient power transfer to a plasma processing chamber, by solving the problem of transient fluctuations in the plasma impedance, caused when switching between successive processing steps. An impedance matching circuit allows efficient power transfer, but without adjustment it will normally only be efficient for a given value of the plasma impedance, and will not be able to maintain its efficiency during the fluctuations. The invention of US 09/674,925 addresses this problem by teaching that the plasma is stabilized during the transitions from the first etching to the second deposition steps and/or during the transitions from the second deposition to first etching steps.

The invention also teaches that this action of stabilizing should be an active process, involving the adjustment of a processing parameter. This is dynamically adjusted either to improve the impedance matching during the impedance fluctuations or to suppress the fluctuations themselves. This is evident from the following portions of the description.

- Page 3, line 10 to page 4, line 9, where the variable circuit components of an impedance matching unit are to be adjusted so as to achieve the desired result.
- Page 4, line 10 to page 5, line 14, where the parameter to be adjusted is the frequency of the power supply.
- Page 5, line 15 to page 7, line 2, where the parameters to be adjusted are the flow rates of the etching and deposition gases
- Page 7, lines 3-19, where the parameter to be adjusted is the flow of a buffer gas.
- Page 7, line 20 to page 8, line 4, where the parameter to be adjusted is the pressure in the processing chamber.

In each of these descriptions it is made clear that a parameter is to be varied during the process, so as to minimise the transient fluctuations and/or their effect on the impedance matching.

5. The Examiner has repeatedly drawn attention to the teachings of Beaudry, and the Examiner believes that Beaudry sought to address a similar issue to that addressed by the current invention. However, the approach dynamically adjusting a

processing parameter to stabilize the plasma was clearly not part of Beaudry's thinking, since he criticizes the prior art by stating (col 1, line 45-50) that: '*The periodic and critical manual tuning of these variable impedances is difficult to accomplish quickly, and consequently the processing program must be constantly interrupted while the operator searches for impedance settings required to minimise the reflected power as the above parameters are changed.*'

Beaudry instead developed a solution (col 1, line 61-68) that would not require such adjustments: '*It is accordingly an object of the invention to provide an impedance-matching unit which will automatically provide, without any required manual adjustment whatever, substantial impedance matching between the generator and capacitive electrodes of the gaseous plasma chamber continuously and throughout a range of changing parameters required to carry out a known plasma-chemical process.*'

6. The solution proffered by Beaudry is an entirely passive electrical circuit, which seeks to maintain '*substantial*' impedance matching despite parameter fluctuations. Fig 2 shows a schematic embodiment. This contains only two variable components, which are described (col 4, lines 9-14) as follows: '*a trimmer inductor 76 is connected across inductor 51 to adjust the effective inductance thereof; and a trimmer capacitor 77 is connected in parallel across capacitor 62. The variable components are factory-adjusted with the plasma in*

operation... These components are therefore emphatically not dynamically adjusted during the process in the manner of the current invention.

7. Beaudry's solution to the problem posed by fluctuating plasma conditions is to provide apparatus that, rather than dynamically responding to the changing situation, seeks approximately to satisfy the impedance matching requirement over a broad envelope of parameter values. It does not in any way respond to the fluctuations, so does not provide the teaching of US 09/674,925.
8. Although the term "automatic impedance matching network" is used in Beaudry, this term does not imply any kind of adjustment of a processing parameter in order to compensate for impedance mismatches and hence to stabilize the plasma. In fact, I believe that it is clear that by "automatic", Beaudry means that adjustments are not required. This is because Beaudry provides apparatus that will inherently - ie, without adjustment- satisfy the impedance matching requirement over a broad envelope of parameter values owing to its generally low Q factor.
9. I further declare that all statements made herein of my own knowledge are true, and that all statements or information are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section

1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

By: *L. M. Lea*
Dr. Leslie Lea

Date: 15 November 2006

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